Quarterly Report
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Abstract

Our major achievements of this quarter were focused on: (i) the progress of the MOD_PR06OD *V2* algorithm delivery, including the utilization of cloud mask information, (ii) the completion of file specifications for the combined MOD06 product and progress of Level-3 file specification, (iii) the improvement of MAS-50 channel data processing and archiving, and (iv) the intercomparison of MAS and AVIRIS radiometric data in the shortwave region.

I. Task Objectives

With the use of related airborne instrumentation, such as the MODIS Airborne Simulator (MAS) and Cloud Absorption Radiometer (CAR) in intensive field experiments, our primary objective is to extend and expand algorithms for retrieving the optical thickness and effective radius of clouds from radiation measurements to be obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS). The secondary objective is to obtain an enhanced knowledge of surface angular and spectral properties that can be inferred from airborne directional radiance measurements.

II. Work Accomplished

a. MODIS-related Instrumental Research

To assure good quality of MAS 50-channel data in the shortwave region, we have conducted extensive intercomparisons between the MAS and AVIRIS measurements from two recent field experiments, viz., SCAR-B (Smoke, Clouds, And Radiation-Brazil, August-September 1995) and ARMCAS (Arctic Radiation Measurements in Column Atmosphere-surface System, Alaska, June 1995). Different types of scenes with large dynamical ranges, such as no cloud, partly cloudy, and mostly cloudy (very bright) scenes, were chosen as representative test datasets. For each target the average radiance was computed for all MAS 25 bands and the AVIRIS radiances were convolved into corresponding MAS band shapes. Two important conclusions can be summarized from this exercise: (i) MAS data, particularly for bands 1-9 (port 1), are often offset higher than AVIRIS data, especially over scenes that are very bright (such as over areas of extensive clouds or arctic sea ice). The port 1 offset peaks at band 7 (0.865 µm). Offsets in bands 10-25 (port 2) during ARMCAS showed little change regardless of scene type, although they do appear slightly higher for SCAR-B over bright scenes. (ii) Instrument temperature appears to have some effects on the slope values of the comparisons, as evidenced by relative changes in slope values across the different bands. The pattern of change across port 1 matches the expected sensitivity of the different silicon bands to temperature change. Due to the nature of this type of comparison, it is not conclusive as to whether MAS or AVIRIS (or both) are responsible for the differences noted, though there is some suggestion that the temperature correction used in the MAS processing may not be fully modeling the MAS thermal responsivity. Results from these comparisons were discussed with Ames personnel. Plans are underway to set up some laboratory tests at Ames to simulate the higher offset over bright scene as noted. In addition, we are reviewing possible cases for 1996 MAS-AVIRIS comparisons. Because there were many instrumental changes in the MAS in early 1996, data obtained following these changes should be analyzed to see if the same effects are noted as were in 1995 (ARMCAS and SCAR-B) data.

b. MODIS-related Data Processing and Algorithm Study

Data processing, with final calibration, of MAS Level-1B data was completed for all nine ARMCAS flights. This new version of MAS data is no longer inventoried in slices. Individual flight tracks are now tagged by date and flight track number. A new set of browse images and summary statistics have been attached to the MAS Web site (http://ltpwww.gsfc.nasa.gov/MAS). In addition, new in-line thumbnail images (linked to larger/higher resolution images) of the flight pattern are provided for individual MAS missions. These thumbnail maps should assist MAS data users in selecting interested mission days quickly. Interested users can obtain a copy of these data by contacting the Goddard DAAC (Pat Hrubiak at hrubiak@daac.gsfc.nasa.gov) in either Digital Linear Tape or Exabyte 8500 Tape. Typical Level-1B HDF output files vary between 100 and 800 megabytes. The SCAR-B Level-1B processing with final calibration has been completed for the first four flights: 16, 18, 20, and 23 August 1995.

Recent field campaigns of SUCCESS (SUbsonic aircraft: Contrail and Cloud Effects Special Study, Kansas, April-May 1996), TARFOX (Tropospheric Aerosol Radiative Forcing Observational eXperiment, Wallops Island, Virginia, July 1996), and WINCE (WINter Cloud Experiment, Wisconsin, February 1997) adopted the “Golden Day” concept whereby preliminary calibration coefficients were adopted for quick data processing shortly after the completion of the experiment. All browse images and flight track summary statistics are available from the MAS WWW site.

The Web site for CAR (http://climate.gsfc.nasa.gov/~jyli/CAR.html) was recently established, and it serves as an information center for the CAR data user community. New data from the UV calibration, conducted in December 1996, were processed and analyzed to inferred slope and intercept values. All SCAR-B and ARMCAS CAR data including UV have been reprocessed into HDF format and a much improved version of quicklook images was produced that presents six-bands-worth-of radiometric information simultaneously. A readCarData subroutine is also provided, which interfaces with the CAR HDF data objects and returns radiance (in units of W m^{-2} sr^{-1} μm^{-1}), scan angles of each pixel, solar zenith and azimuth angle, aircraft heading, etc. With these useful parameters, a CAR HDF data user can compute BRDFs without a need to know details of the HDF data structure.

Our work on the MODIS cloud retrieval (MOD_PR06OD *V2*) algorithm delivery is progressing. In particular, seven MODIS bands (0.65, 0.86, 1.24, 1.64, 2.13, 3.75, and 11.03 µm) for cloud retrievals have been synthesized into the code and restructured for optimal performance. This code will retrieve cloud optical thickness by using different MODIS bands for different surface types (0.65 µm over land, 0.86 µm over ocean, and 1.24 µm over snow / ice) at the pixel level and optical thickness will be reported at 0.65 µm. New programs to handle MODIS cloud mask information, including interfaces provided by SDST, are also being developed and integrated, which is critical to the cloud retrieval decision tree. First-cut logic and code structure were incorporated to retrieve either water-cloud or ice-cloud parameters at a pixel level. Two typical ice cloud phase functions and other optical parameters were provided by Prof. K. N. Liou's group at the University of Utah for exercising our ice cloud lookup table generation. We performed general algorithm tests of MOD_PR06OD by using MAS ARMCAS field experiment data and further test are underway.

We have completed and submitted to SDST the file specification for the combined MOD06 product and added the HDF-EOS information and metadata to the CDL (network Common data form Description Language) version of the file specification. Preparation for the Level-3 file specification is underway. We have finalized the statistics and approaches to be used for Level-3 aggregations for each Level-3 parameter. In addition, we completed the list of Level-3 parameters based on inputs from all MODIS Atmosphere team members as well as the GCM community.

c. MODIS-related Services

1. Meetings

1. Xu Liang, Ran Song, and Menghua Wang attended the MODIS Level-3 module process meeting, held at Goddard, on 24-25 February 1997. Dr. Liang presented a preliminary study on wavelets and their application to aerosol data;

2. Si-Chee Tsay attended the Conference on Weather Analysis and Forecasting, held in Taipei, Taiwan, on 3-7 March 1997, and presented an update on EOS remote sensing and retrievals of atmospheric aerosols and clouds;

3. Steve Platnick and Michael King regularly attended weekly MODIS Technical Team meetings.

4. Michael King attended the *Topical Meeting on the Optical Remote Sensing of*

the Atmosphere, Santa Fe, NM, on February 10-13, where he gave an invited talk entitled: "Remote sensing of cloud, aerosol, and water vapor properties from the Moderate Resolution Imaging Spectroradiometer (MODIS)."

2. Seminars

1. King, M. D., "NASA's Mission to Planet Earth," at Amundsen-Scott South Pole Station (January).

2. Pincus, R., "In situ measurements of the absorption of solar radiation by stratiform water clouds," at the Geophysical Fluid Dynamic Laboratory, Princeton, New Jersey (January), and at NASA Langley Research Center, Hampton, Virginia (March), 1997.

3. Pincus, R., "Lumpy clouds: Understanding spatial and temporal variability in marine stratocumulus," Columbia University / NASA Goddard Institute for Space Studies Graduate Student Seminar Series, New York, January 1997.

III. Anticipated Activities During the Next Quarter

a. Continue to work on the MODIS *v2* cloud retrieval algorithm delivery, including the cloud mask interface, ice / water cloud logic tree, and QA flags;

b. Extend retrieval libraries to include ice cloud models for the MODIS *v2* software delivery;

c. Continue to analyze MAS, AVIRIS, and CLS data gathered during the ARMCAS campaign, as well as AVHRR, University of Washington C-131A in situ data, and surface data, all with the express purpose of helping to develop the MODIS cloud masking algorithm;

d. Continue to analyze MAS, AVIRIS, and CLS data gathered during the US-Brazil SCAR-B campaign, as well as University of Washington C-131A in situ and radiation data to study aerosol mask and aerosol-cloud interactions;

e. Continue to analyze surface bidirectional reflectance measurements obtained by the CAR during the Kuwait Oil Fire, LEADEX, ASTEX, SCAR-A ARMCAS, and SCAR-B experiments, as well as analyze CAR diffusion domain data from MAST and FIRE-87;

f. Attend the CERES (16-19 April) and MODIS (14-15 May) science team meetings at NASA Langley Research Center, Hampton, VA, and College Park, MD, respectively;

g. Attend the FIRE Arctic cloud working group meeting (12-13 May) at the NCAR Foothills Lab., Boulder, Colorado;

h. Attend AGU Spring meeting and SCAR-B, TARFOX, and SUCCESS science workshops (27-30 May) in Baltimore, Maryland.

IV. Problems/Corrective Actions

No problems that we are aware of at this time.

V. Publications

1. Platnick, S., P. A. Durkee, K. Nielson, J. P. Taylor, S. C. Tsay, M. D. King, R. J. Ferek, P. V. Hobbs, and J. W. Rottman, 1997: The role of background cloud microphysics in the radiative formation of ship tracks. *J. Atmos. Sci*., in press.

2. Li, J. Y., H. G. Meyer, G. T. Arnold, S. C. Tsay, and M. D. King, 1997: *The Cloud Absorption Radiometer HDF Data User's Guide*. NASA Technical Memorandum 104643, 34 pp.

3. King, M. D., S. C. Tsay and S. A. Ackerman, 1997: MODIS Airborne Simulator: Radiative properties of smoke and clouds during ARMCAS and SCAR-B. *Proc. Third International Airborne Remote Sensing Conference and Exhibition,* Copenhagen, Denmark.

4. Soulen, P. F., R. Pincus, S. C. Tsay and M. D. King, 1997: Cloud Absorption Radiometer: Airborne measurements of clouds and surface reflectance. *Proc. Third International Airborne Remote Sensing Conference and Exhibition*, Copenhagen, Denmark.